U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

Test Operations Procedure (TOP) 1-2-501 30 June 1995
AD No.

RAIL IMPACT TESTING

1. SCOPE.

a. This TOP describes the techniques for the acquisition and analysis of rail impact data and procedures for conducting a rail impact test. It is used to verify the structural integrity of the test item and the adequacy of the tiedown system and the tiedown procedures. This TOP is intended for vehicles and equipment that will be transported by rail; to determine the effect of normal railroad car impacts that occur during rail shipment.

b. This TOP is not intended for the separate testing of small, individually- packaged pieces of equipment that would normally be shipped (and tested) when mounted on a pallet. It does not cover vibration induced by railcar movement.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

Item	Requirement
Straight level section of railroad track minimum of 200 m with additional track to be able to reverse the test railcar for impacting in the opposite direction	To provide distance to accelerate the test item car to the desired velocity
Locomotive or Inclined Ramp	To accelerate the railcar with the test item to the desired pre-impact velocity

Item	Requirement
Railcar equipped with standard draft gear couplers and a conventional underframe (without cushioning)	To transport the test item into the anvil (buffer) car(s)
Railcar(s) (1 to 5) with total weight of 114,000Kg minimum, equipped with standard draft gear couplers and a conventional underframe (without cushioning)	To act as anvil (buffer) car(s) into which the test item car is impacted
Temperature conditioning source of chamber (if required)	To provide the required temperature environment for the test item

2.2 Instrumentation.

Devices for Measuring	Measurement Accuracy
Rail impact speed (timers)	±0.08 km/hr
Distance between speed timers (measuring tape)	±3 mm
Locomotive speed (speedometer)	±0.16 km/hr
Coupler Force (strain gaged coupler)	±2.2 kN (500 lb_f)
Initial Cable Tension (cable tensiometer)	±90 N (20 lb_f)
Tiedown Bolt Torque (torque wrench)	±5% of reading
Acceleration (accelerometers) (if required)	±0.05 g
Strain (strain gages) (if required)	±5 microstrain
Temperature (thermocouples) (if required)	±2°C
Optical Instruments (video, movie, and still cameras)	As required

3. REQUIRED TEST CONDITIONS.

3.1 Test Planning.

a. Review previous test reports of similar test items.

b. Acquire Military Traffic Management Command (MTMC), Army Materiel Command (AMC) or U.S. Army Defense Ammunition Center and School (USADACS) approved blocking and tie-down instructions.

c. Check applicable equipment publications for special transportability requirements. This may include the basic vehicle weight plus additional payload weight for equipment, ammunition, etc.

d. Satisfy the requirements of MIL-STD-209[1*] for the lifting and tie-down provisions of the test item.

3.2 Test Preparation.

a. Verify the calibration of all speed measuring devices (locomotive and impact speed) and instrumented coupler.

b. Note any existing damage to the test item or railcars including damage to chains, linkages, binders, or other load-securing devices.

c. Ensure that the personnel operating the locomotive or inclined ramp have been properly trained.

d. Ensure that all items are tested at their maximum gross weight (fully loaded) rating unless otherwise specified in the transportability requirements.

e. Ensure that blocking and tie-down are in accordance with Military Traffic Management Command (MTMC), Army Materiel Command (AMC) or U.S. Army Defense Ammunition Center and School (USADACS) approved procedures[a]. Load, block, brace, and tie down the test item on the railcar in accordance with procedures approved by MTMC, USADSCS and procedures found in the test item's technical manual or AMC drawings. Torque nuts on wire rope clips to their correct value. Torque cable clamps to 61 J (45 lb-ft) for 0.95-cm (3/8-in.) wire rope cable, 88 J (65 lb-ft) for 1.3-cm (1/2-in.) and 129 J (95 lb-ft) for 1.6-cm (5/8-in.) wire rope cable.

f. Substitute (dummy) loads must be of equal weight, weight distribution, and size as the actual load that it is replacing.

g. Place speed indicator instrumentation, to determine the speed of the loaded railcar at impact, in position and calibrate prior to test operation.

*Superscript numbers/letters correspond to those in Appendix A, references.

Position the instrumented coupler for coupling on the impacted end of the stationary car(s) to measure coupler force during impact. Position additional transducers such as accelerometers (in three mutually perpendicular axes), strain gages, thermocouples, etc. at select locations on the test item and railcar deck, if required. Attach a calibrated speedometer to the locomotive and use as a speed indicator for the locomotive engineer.

h. Prior to rail impact testing, take characteristic photographs to document the tie-down procedures. In addition, video coverage may be provided for each impact test.

3.3 Test Controls.

a. Observe all safety procedures in accordance with the Safety Assessment Report (SAR), and facility safety regulations.

b. Conduct the test only when rails are dry to minimize variability due to sliding (acceptable conditions to be determined by rail impact test director, Military Traffic Management Command representative and locomotive engineer).

4. TEST PROCEDURES.

4.1 Rail Impact Test.

a. Accomplish the rail impact by securing the test item on a railcar and propelling the car, by means of a locomotive (or by inclined ramp), into one to five stationary anvil (buffer) cars. Measure actual impact speeds by determining the speed of the loaded railcar immediately prior to impact.

b. Position the stationary railcar(s) with their couplers compressed and their air and hand brakes set. Position the knuckles of the anvil and test cars for coupling.

c. Subject the moving railcar to impacts at speeds of 6.4 and 9.6 km/hr (4 and 6 mph) $\pm$5 % and 12.9 km/hr (8 mph) + 5 % / - 0 %. (If the speed is below 12.9 km/hr, repeat the impact.) Conduct the impact by accelerating the railcar to the desired speed using either a locomotive equipped with a speed-measuring device or inclined ramp. Release the railcar loaded with the test item approximately 15 m from the stationary anvil (buffer) railcars and allow to coast until it impacts.

d. Turn the railcar with the test item and repeat the test at 12.9 km/hr + 5 % / - 0 % for a total of four impacts.

e. At the conclusion of each impact, inspect the test item and its blocking and bracing for evidence of possible failure of the tie-down devices and transported test item for equipment damage. Take photographs of the extent of damage as needed. Once the test has started, there will be no

readjustment of the test item nor any reconditioning of the bracing, chock material, or tie-down cables. If the initial blocking and tie-down devices fail, repeat the entire test provided a revised method of securing is feasible and approved by MTMC, AMC or USADACS. At the completion of the test, examine the test item for any permanent displacement or damage and conduct a functional and operational checkout test. Conduct a visual examination of the test item and compare the results with the pretest data.

f. If the test item can be transported in more than one orientation (such as lengthwise and crosswise on the railcar), repeat the four impacts for each orientation.

g. Based on individual systems specifications, higher test speeds may be necessary in order to attain a higher level of confidence in the test item's ability to survive railcar impacting. Conduct the higher speed impacts after successful completion of the two 12.9-km/hr (8-mph) impacts listed above. Conduct these impacts at each higher speed once in each direction prior to proceeding to the next higher speed. Conduct a performance check to establish baseline data prior to proceeding to higher speeds.

4.2 Temperature Conditioning.

a. If the rail impact test is to be conducted at temperature extremes, prior to impacting:

(1) Secure the test item on the railcar and place the test item in the temperature chamber/enclosure and adjust the chamber air temperature to the test temperature. The temperature chamber/source should be located as close to the rail impact site as possible for best efficiency.

(2) Following temperature stabilization of the test item, maintain the storage temperature for a period as specified in the test plan before rail impact testing.

NOTE: Temperature stabilization is attained when the temperature of the operating part of the test item considered to have the longest thermal lag is changing no more than 2°C per hour.

(3) Disconnect the temperature conditioning chamber/source, if employed and perform the rail impact test as stated in paragraph 4.1.

If the test item is considered by itself in a temperature chamber rather than on the railcar, after the conditioned item is mounted on the railcar:

(1) Replace the test item in the temperature chamber and adjust chamber air temperature to the test temperature.

(2) Following temperature stabilization of the test item, maintain the storage temperature for a minimum of twice the amount of time that the

test item has been out of the temperature chamber.

(3) Perform the rail impact test as stated in paragraph 4.1.

b. If the test item remains outside the conditioning chamber for more than 15 minutes then reconditioning is required. If more impacts are required after 15 minutes, the test item shall be reconditioned for 30 minutes after the test item has stabilized at the required test temperature.

4.3 Failure Definition.

A test item shall be classified as not having survived the rail impact test and will be considered a failure if any item that is attached to or included as an integral part of the test item breaks free, loosens or shows any sign of permanent deformation beyond specification tolerances.

5. DATA REQUIRED.

5.1 Rail Impact Test.

a. Documentation of the blocking and tie-down devices used to secure the test item (photos, drawings, materials list, etc.).

b. Description of existing damage on test item or railcars.

c. Description of the railcar including maximum coupler travel.

d. Description of test item including weight and dimensions and general location on test car.

e. Direction of the impact (define forward end of test item).

f. Impact speed.

g. Force imparted on the impacted coupler of the stationary railcars.

h. Results of examination and operational checkout tests.

i. If necessary, transducer measurements (i.e., acceleration, temperature, strain, etc.) of various locations on the test item and railcar.

j. Effects on the test item, blocking and tie-down devices including deficiencies, shortcomings, or limitations observed during rail impacting.

6. DATA PRESENTATION.

a. Prepare photographs and/or sketches of blocking and tie-down configuration.

b. Prepare graph of peak coupler force versus actual impact speed.

c. Prepare photographs of setup, instrumentation, and any damaged components.

d. If required, compile tables of peak acceleration levels and/or plots of time versus acceleration for each impact.

e. If required, present video documentation of actual impacts.

f. Prepare any pertinent graphs to represent other transducer measurements, if required (i.e., strain versus time, temperature recordings, etc.).

APPENDIX A. REFERENCES

1. MIL-STD-209H, Military Standard, Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment, 29 June 1991.

REFERENCES FOR INFORMATION ONLY

a. Association of American Railroads, "General Rules Governing the Loading of Commodities on Open Top Cars", updated yearly.

TOP 1-2-501
30 June 1995

Recommended changes of this publication should be forwarded to Commander, U.S. Army Test and Evaluation Command, ATTN: AMSTE-CT-T, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, U.S. Army Aberdeen Test Center, ATTN: STEAC-AC-I, Aberdeen Proving Ground, MD 21005-5059. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145. This document is identified by the accession number (AD No.) printed on the first page.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	30 Jun 1995	Final

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
1-2-501 Rail Impact Testing

5. FUNDING NUMBERS
WU A268445

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 1-2-501

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Commander
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10. SPONSORING/MONITORING AGENCY REPORT NUMBER
Same as Item 8

11. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD NO: A _____

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This TOP describes the techniques for the acquisition and analysis of rail impact data and procedures for conducting a rail impact test.

14. SUBJECT TERMS
Rail impact Blocking
Couplers Transportability
Tie-downs Anvil car

15. NUMBER OF PAGES
10

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED			SAR